



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
WASHINGTON, D.C. 20546

Johnson

REPLY TO  
ATTN OF GP

OCT 15 1973

TO: KSI/Scientific & Technical Information Division  
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for  
Patent Matters

SUBJECT: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code KSI, the attached NASA-owned U.S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,758,112

Government or  
Corporate Employee : Government

Supplementary Corporate  
Source (if applicable) :  

NASA Patent Case No. : MSC-11561-1

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes  No

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of column No. 1 of the Specification, following the words ". . . with respect to an invention of . . ."

*Elizabeth A. Carter*

Elizabeth A. Carter

Enclosure

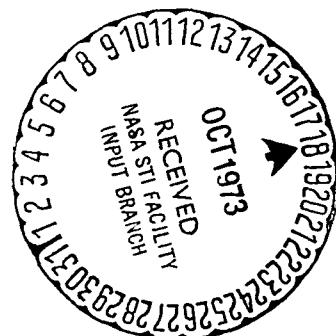
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N73-32014

FOOT PEDAL  
OPERATED FLUID TYPE EXERCISING DEVICE  
CSCL 05E  
(NASA-Case-MSC-11561-1)  
OPERATED FLUID TYPE EXERCISING DEVICE  
Patent (NASA) 6 P

Unclass  
18071

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[54] FOOT PEDAL OPERATED FLUID TYPE EXERCISING DEVICE

[75] Inventors: Gerald W. Crum, Brookfield Center, Conn., Richard J. Sauter, Houston, Tex.

[73] Assignee The United States of America as represented by the Administrator of the National Aeronautics and Space Administration

[22] Filed. May 26, 1971

[21] Appl. No. 146,940

[52] U.S. Cl. 272/79 C, 272/DIG 5, 272/DIG 1, 272/DIG 4, 137/535, 91/186

[51] Int. Cl. A63b 21/00

[58] Field of Search 272/99 C, 79 R, 72, 272/57 R, 83, DIG 1, DIG 5, 60/975 E, 52 5, 73/379, 91/186, 412, 137/535

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Primary Examiner—Richard C. Pinkham

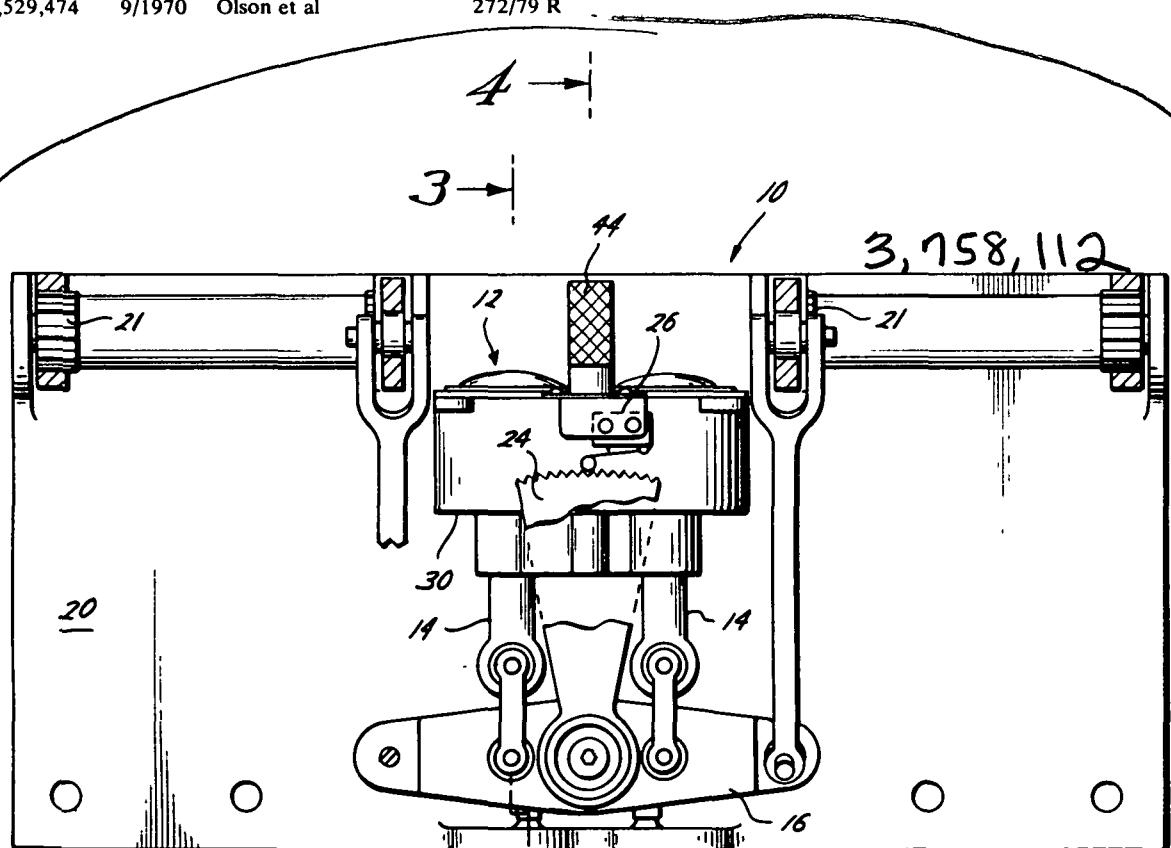
Assistant Examiner—William R. Browne

Attorney—Russell E. Schlorff, Marvin F. Matthews and John R. Manning

[57] ABSTRACT

A foot pedal operated exercising device containing a dynamometer formed of a pair of cylinders each containing a piston. The pistons are linked to each other. The upper portions of the two cylinders are joined together by a common opening to provide a common fluid reservoir and each piston is provided with a one way check valve to maintain an adequate supply of working fluid. Fluid from the driven cylinder is transmitted to the other cylinder through separate constant force spring biased valves each valve takes the predominant portion of the pressure drop thereby providing a constant force hydraulic dynamometer. A device is provided to determine the amount of movement of piston travel.

9 Claims, 6 Drawing Figures



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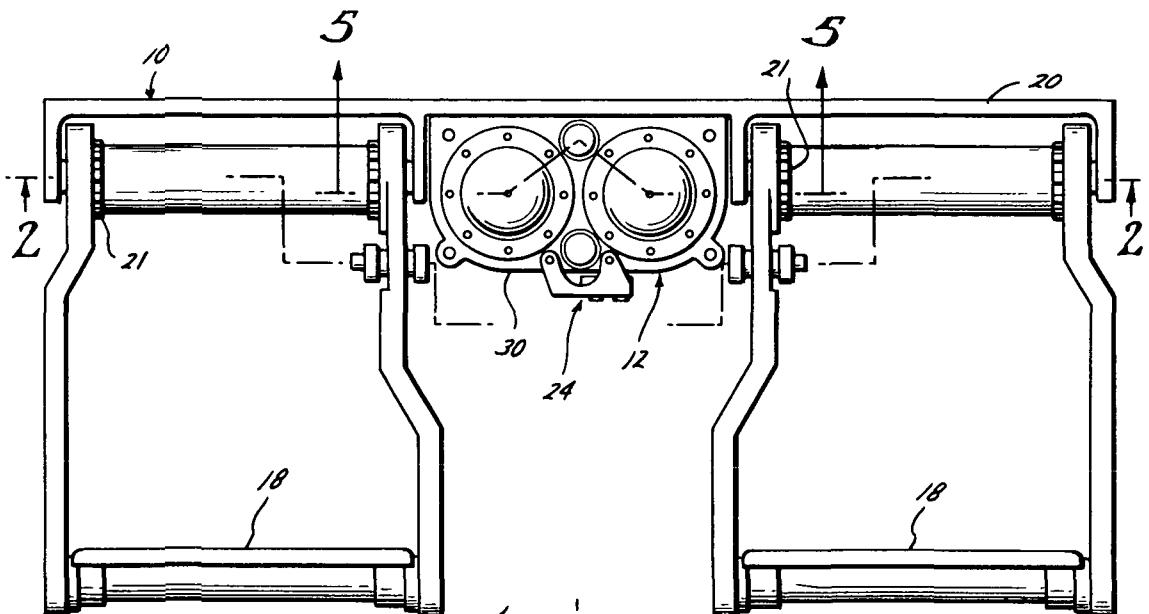


Fig. 1

4 →

3 →

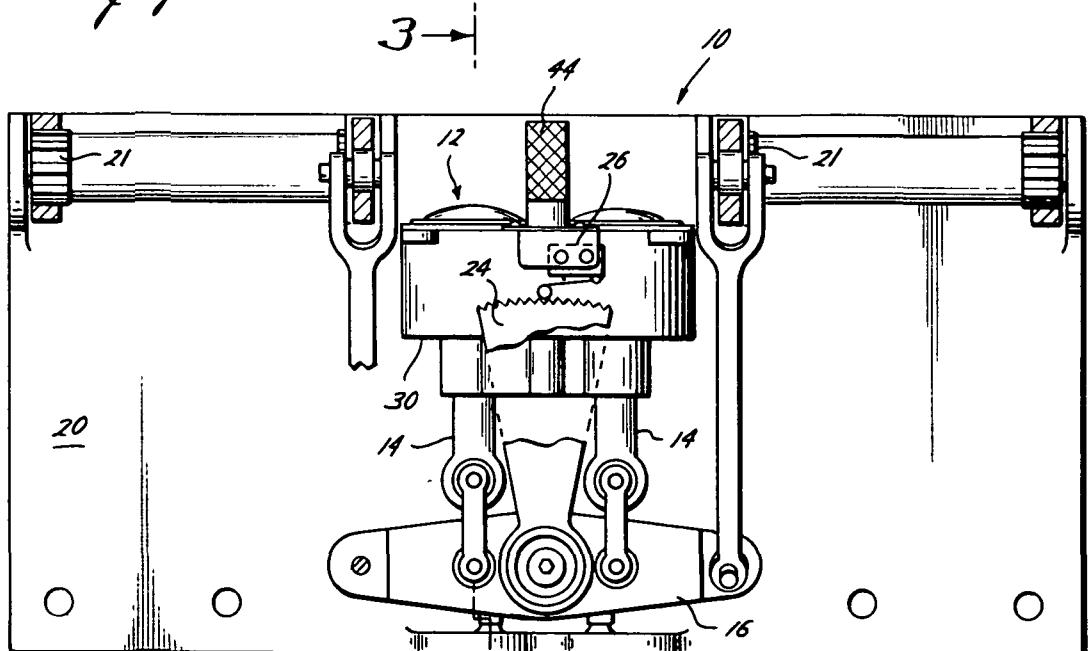


Fig. 2

3 →

4 →

Gerald W. Crum  
Richard J. Sauter  
INVENTORS

BY

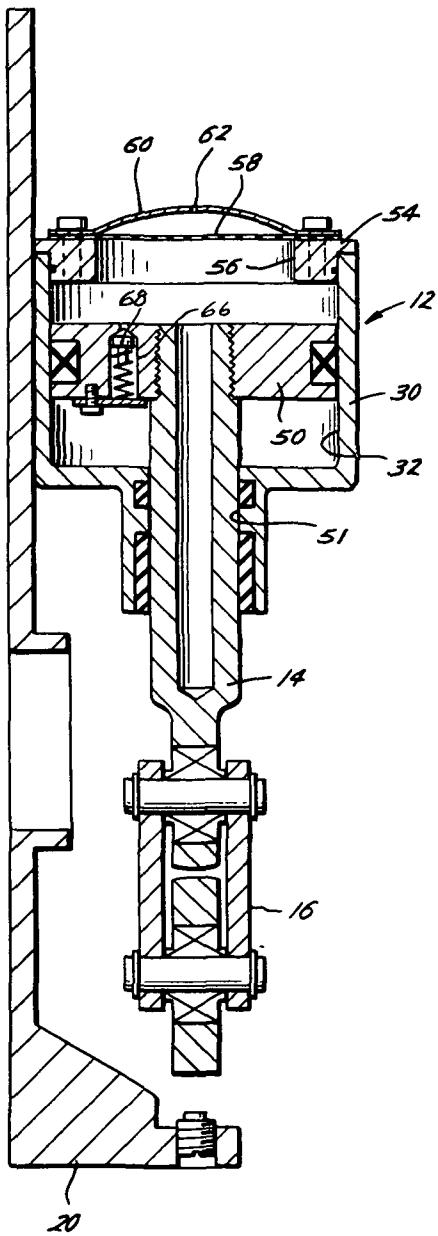
Ronald S. Schlafly  
ATTORNEY

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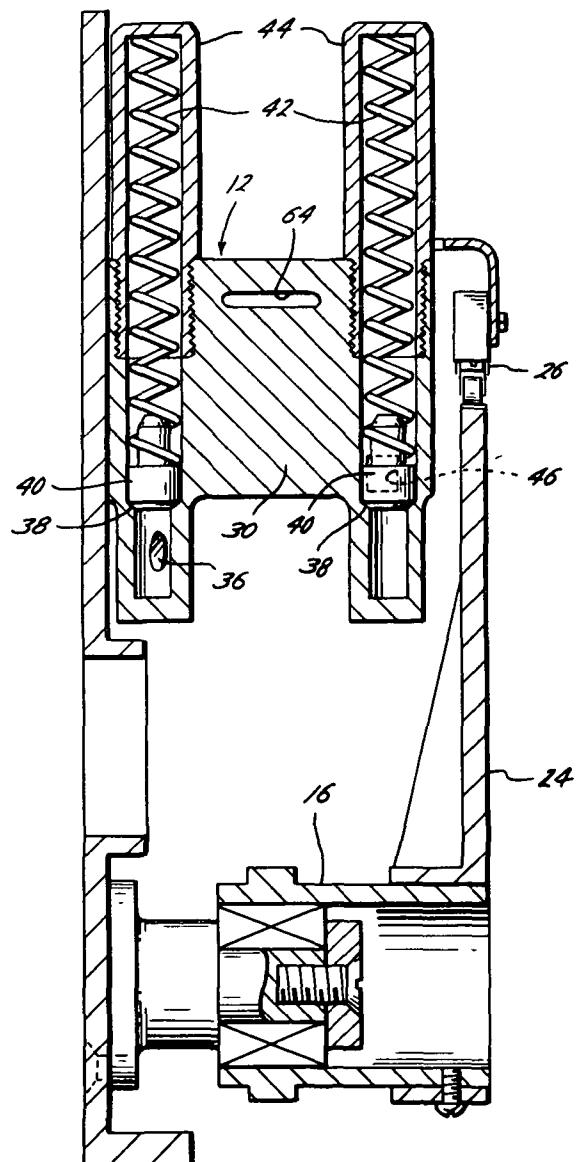
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*Fig. 3*



*Fig. 4*



Gerald W. Crum  
Richard J. Sauter  
INVENTORS

BY

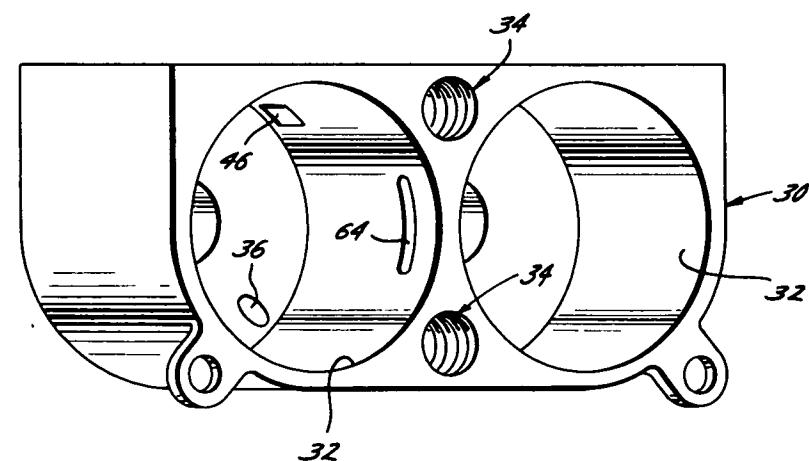
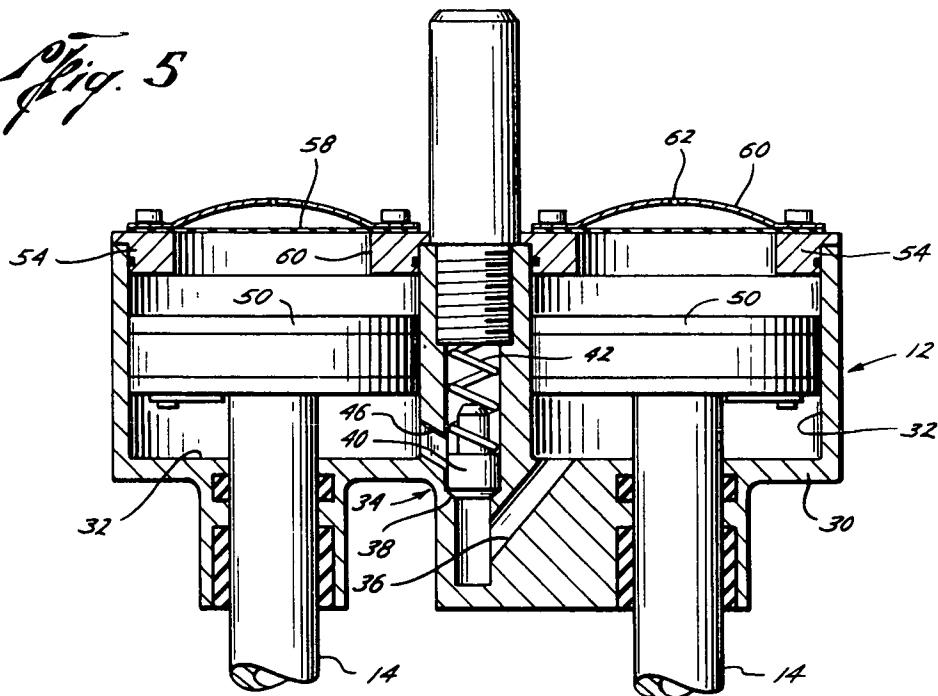
Russell S. Schloff  
ATTORNEY

PATENTED SEP 11 1973

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*Fig. 5*



*Fig. 6*

Gerald W. Crum  
Richard J. Sauter  
INVENTORS

BY

Russell E. Schlosser  
ATTORNEY

## FOOT PEDAL OPERATED FLUID TYPE EXERCISING DEVICE

### ORIGIN OF THE INVENTION

The invention described herein was made by employees of the United States Government and may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

### BACKGROUND OF THE INVENTION

This invention relates to a dynamometer and more particularly to an ergometer for use as a quantitative exercise device.

Biomedical experts have determined that immobility for an extended period of time is detrimental to muscle tone, the skeletal frame, and general well being of a human being. Accordingly, it is desirable to provide an exercise device for crew members of spacecraft where, due to small quarters, even customary exercise obtained through normal daily movement does not occur. Due to weight, size, and power requirements, common exercising devices such as bicycles and treadmills which use friction brakes, eddy current brakes, or generators as load sources are unsuitable for use during spaceflight, particularly in the small spacecraft used in the Apollo program. With other exercising devices which use springs or weights as the load source, it is difficult to accurately measure the work load since a force is developed even if there is no motion. Accordingly, it is the purpose of the present invention to provide a lightweight, simple dynamometer which will accurately measure energy developed.

It is another object to provide a small, lightweight, inexpensive, self-contained dynamometer which will have no change in load with a change in speed.

### SUMMARY OF THE INVENTION

In general, the present invention is comprised of a fluid motor in which the driven fluid flows through a spring biased valve and the porting is such that the pressure drop is taken primarily through the valve. Accordingly, there is provided a constant force hydraulic dynamometer which may be utilized as the energy sink for an exercising device. The driven fluid may be transferred to a companion fluid motor to provide a reciprocating device. The pistons may be reciprocated by the pivotal movement of a rocker arm mechanically linked to foot pedals. A counter and sector cam attached to the piston rocker arm provide an accurate determination of work done even if there is not a full stroke each time.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view of an exercising device in accordance with the present invention.

FIG. 2 is a bottom plan view of the exercising device shown in FIG. 1.

FIG. 3 is a sectional view taken generally along lines 3-3 of FIG. 2.

FIG. 4 is a sectional view taken generally along lines 4-4 of FIG. 2.

FIG. 5 is a sectional view taken generally along lines 5-5 of FIG. 1.

FIG. 6 is a view showing connecting cylinders with interconnecting passages.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and particularly to FIGS 1 and 2, it can be seen that the exercising device 10 of the present invention is formed of a dynamometer 12 from which extends two piston rods 14-14. The ends of rods 14 are attached to a rocker arm assembly 16 which is connected to foot pedals 18-18, each of which extends from frame 20 through a pivoted connection 22. Movement of foot pedals 18-18 results in operation of dynamometer 12 which acts as a constant force ergometer. The amount of piston movement is determined by a sector cam 24 which actuates a microswitch 26.

The constant force energy device or dynamometer 12 is formed of a housing 30 attached to frame 20. In housing 30 there are two open ended cylinders 32 (see FIGS 5 and 6). Located between the cylinders is a pressure controlled valve assembly 34, one for each cylinder. Extending from the bottom wall of each cylinder and communicating with the upstream side of the valve assembly is a passageway 36. Located in valve assembly 34 is a valve seat 38 and a pressure controlled valve member 40 which is retained on seat 38 by a constant force spring 42 which may be a spring formed of a large number of turns. The force of spring 42 is regulated by adjustable cap member 44, hence, adjustment of member 44 regulates the fluid pressure required to open valve member 40. The higher the pressure, the greater the energy required by the subject.

Downstream from valve seat 38 is a passageway 46 which communicates with the other cylinder. Accordingly as fluid is driven from one cylinder it passes into the other and in effect there is a set of reciprocating pistons. Instead of having two separate cylinders, the fluid could be alternately transferred from one side to the other side of a double acting piston through pressure controlled valve assemblies.

Located in each cylinder is a piston 50 having piston rod 14 which extends through a centrally located passage 51 located in the bottom wall 52 of each cylinder 12. As can be seen in FIG. 4 there may be seals about piston 50 and in the wall of central passage 51 to prevent leakage between the piston and cylinder wall and about the piston rod.

As previously mentioned, piston rods 14 are attached to foot pedals 18 through rocker arm assembly 16, as foot pedals 18 are stroked, pistons 50 are reciprocated in their respective cylinders. As a result, fluid in the piston rod side of the cylinder is driven by the piston through passageway 36 into valve assembly 34 where it is initially arrested by valve member 40. As the force on the pedal is increased, the pressure on the fluid exerted by piston 50 is increased, hence fluid pressure in passageway 36 increases until the pressure of the fluid in passageway 36 is sufficient to force valve member 40 off its seat, which pressure will exceed the force provided by spring 42. Since spring 42 is designed so that there is a constant force throughout its effective operating length, the movement of the valve member 40 away from its seat 38 will be directly proportional to the amount of energy expended. If stroke rate is increased, the valve member will move further away from its seat allowing the flow of a greater amount of fluid resulting from a greater amount of piston movement at a constant force. Accordingly, there is provided a con-

stant force throughout its effective operating length, the movement of the valve member 40 away from its seat 38 will be directly proportional to the amount of energy expended. If stroke rate is increased, the valve member will move further away from its seat allowing the flow of a greater amount of fluid resulting from a greater amount of piston movement at a constant force. Accordingly, there is provided a con-

tant force hydraulic dynamometer, the energy dissipated being proportional to the force and the rate of its application

The energy in the fluid is dissipated by shearing of the fluid as it crosses the valve seat. Therefore, there are no heat transfer problems since the heat can be carried off by the fluid and dissipated by spreading over a large surface. Accordingly, there is a uniform housing temperature. The fluid accordingly is not only utilized as a working fluid, but also to dissipate the energy and heat. The force required to move the piston will remain essentially constant regardless of speed inasmuch as the major pressure drop is effected by the spring controlled pressure relief valve. Therefore within any reasonable range of speed, the force necessary to move the pistons will remain constant. Excessively high speed could cause some increase in load due to friction of the fluid in moving through the passageways. Accordingly, it is desirable that the passageways be of such size that the pressure drop is predominantly taken at the valve assembly.

The open end of each cylinder may be provided with a closure member 54 having a central opening 56 which is closed by a rubber diaphragm 58. A protective cover 60 covers the diaphragm 58. The cover 60 is provided with a vent 62. A transfer passageway 64 connects the upper portion of the two cylinders. The upper portion of the cylinders may be provided with excess fluid which may be transferred from one cylinder to the other through passageway 64 providing a reservoir of working fluid for the dynamometer. Each piston may be provided with a passageway 66 in which is located a check valve 68. Accordingly, if there is a loss of working fluid, excess fluid will flow through piston into the working portion of the device.

As previously mentioned, the amount of movement of the dynamometer is determined by the movements of mechanism 24 which may be a sector cam having a plurality of indentations, each indentation causing the energizing of microswitch 26 therefore by counting the number of activations of microswitch 26 the total amount of piston movements is determined regardless of whether there are full strokes or incomplete strokes of pedals 18.

As can be seen from the foregoing there is provided a constant force hydraulic dynamometer which may be used effectively as a load source in an exercising device. The invention may be incorporated into linked cylinders to provide a pair of pistons which may be reciprocated by a rocker arm assembly attached to a pair of foot pedals.

We claim

1. A fluid dynamometer for use in an exercising device comprising

a housing containing a pair of cylinders having their longitudinal axes in a common plane, each cylinder having a bottom wall and an open end and a centrally located passage in the bottom wall,

a piston each cylinder, the piston having a rod connected to the working end of the piston and extending through the centrally located passage; the housing also having a pair of valve assemblies, each valve assembly having a valve seat and a pressure controlled valve member cooperative with the valve seat,

a pair of first passages, each of said first passages extending, respectively from the bottom wall of each cylinder to the upstream side of one of the valve assemblies,

a pair of second passages, each of said second passages extending respectively from the downstream side of each valve assembly to a location adjacent to each bottom wall of the cylinder the locations of the connections of each of said first and second passages in each cylinder being spaced apart from each other the valve assemblies providing separate independent paths of fluid communication from one cylinder to the other cylinder, the second passages having a cross sectional configuration whereby fluid being driven from one cylinder to the other cylinder will take the predominant portion of its pressure drop across the valve seat and dissipate heat generated, and

force receiving means connected to the piston rods to receive a force to drive the piston toward the bottom wall, the force required to move the piston being relatively independent of speed of movement.

2. The dynamometer specified in claim 1 including means closing the open end of each cylinder and a transfer passage between the cylinders

3. The dynamometer specified in claim 2 including each piston having a passage and a one-way check valve so that fluid in a reservoir end of one cylinder may be transferred to the working end of the piston in the other cylinder

4. The dynamometer specified in claim 1 including means to adjust the pressure on the valve member

5. The dynamometer specified in claim 4 wherein the means adjusting the pressure on the valve member is an adjustable cap member

6. The dynamometer specified in claim 1 including means mechanically linking the two pistons together and pedals for foot operation connected thereto

7. The dynamometer specified in claim 6 including means to determine the amount of piston movement

8. The dynamometer specified in claim 7 in which the means to determine the amount of piston movement is formed of a microswitch actuated by a sector cam attached to the means linking the pistons together

9. The exercising device set forth in claim 1 including a pair of fluid motors connected through a mechanical linkage to a pair of foot pedals and a pair of metering means interconnecting the fluid motors

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